THE UNIVERSITY of York

EPSE Project 1: Sample Diagnostic Questions - Set 6

Forces and motion
These questions all probe pupils' understanding of the connection between forces and motion.

Qs1-3 look at a simplified model of the forces on a car when it is speeding up, going at a steady speed, and slowing down. Of these, pupils are likely to find Q1 the easiest, and Q2 the most difficult -–with many wanting to indicate a net force forwards to maintain the steady speed. These three questions all ask about total force as well as the individual forces, allowing you to check if pupils' answers to the two parts of each question are consistent. Q4 also probes the same ideas, but in a different and unfamiliar situation.

Qs5-7 probe another situation that pupils find difficult to analyse in terms of forces acting – an object that has been set in motion but is now slowing down. Again many choose to mark a force in the direction of motion. Questions like these are very good for group discussion, prior to a class discussion.

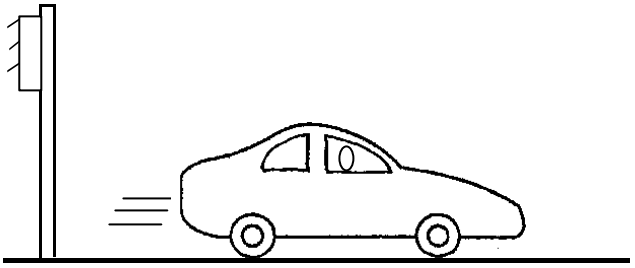
Qs8-9 probe understanding that, in the absence of external forces, an object travels in a straight line. Many pupils think (wrongly) that circular motion will persist, to some extent at least.

Q10 is another good small group discussion question, bringing together all the key ideas about how forces can explain motion, and the 'at rest' situation.

These questions are taken from a larger bank of diagnostic questions and tasks developed by the *Evidence-based Practice in Science Education (EPSE) Research Network*. We hope to publish the whole set of materials later in 2003. In the meantime, this sample may suggest ideas for developing more questions along similar lines.

1

A car is just starting up after stopping at traffic lights.



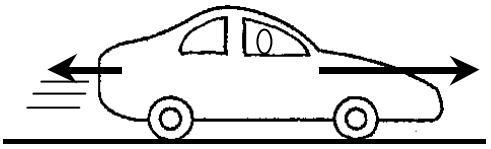
We can think of the forces acting on the car as:

- a **driving force** caused by the engine
- a **counter force** caused by air resistance and friction

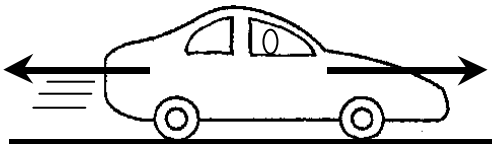
(a) **The speed of the car is increasing.** Which of the following best describes the size of these two forces, while the car is speeding up?

Tick ONE box (✓)

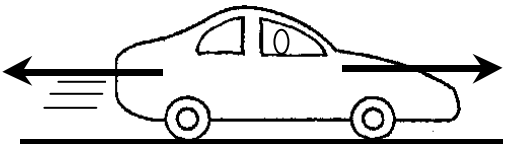
☐ The driving force is **a lot bigger** than the counter force.



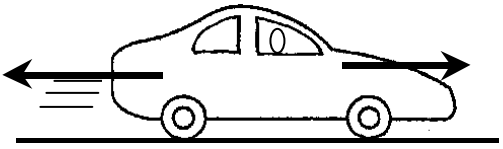
☐ The driving force is **a little bit bigger** than the counter force.



☐ The driving force is **exactly the same size** as the counter force.



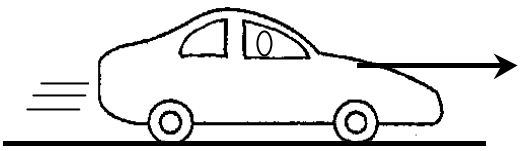
☐ The driving force is **smaller than** the counter force.



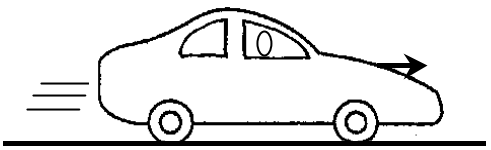
(b) The **total force** acting on the car is the sum of the driving force and the counter force. What is the total force acting on the car while it is **speeding up**?

Tick ONE box (✓)

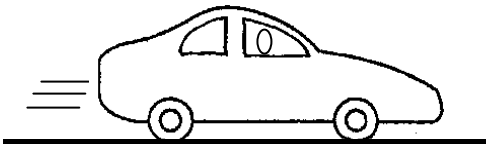
☐ The total force is **quite a large force** forwards.



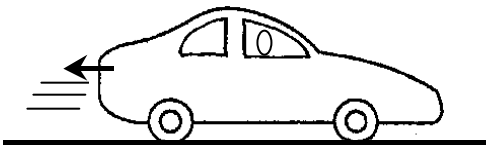
☐ The total force is **a small force** forwards.



☐ The total force is **zero**.

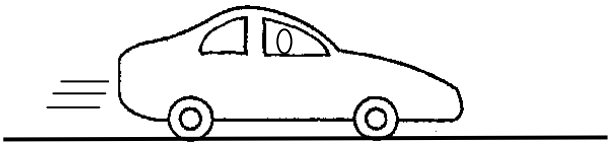


☐ The total force is **a small force** backwards.



2

A car is travelling along
a level road at a steady speed.



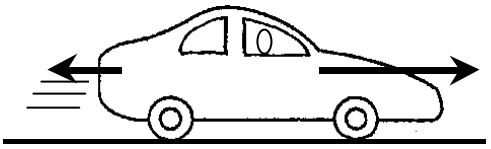
We can think of the forces acting on the car as:

- a **driving force** caused by the engine
- a **counter force** caused by air resistance and friction

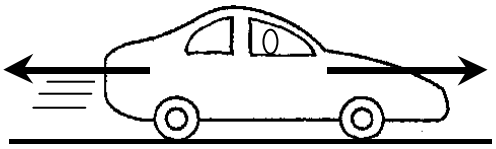
(a) **The car is travelling at a steady speed.** Which of the following best describes the size of these two forces?

Tick ONE box (✓)

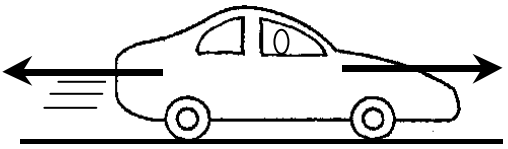
☐ The driving force is **a lot bigger** than the counter force.



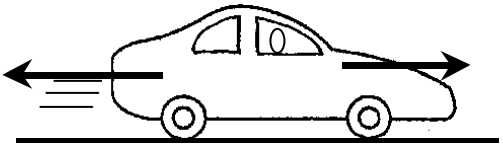
☐ The driving force is **a little bit bigger** than the counter force.



☐ The driving force is **exactly the same size** as the counter force.



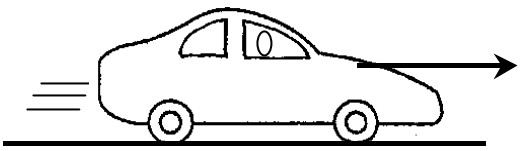
☐ The driving force is **smaller than** the counter force.



(b) The **total force** acting on the car is the sum of the driving force and the counter force. What is the total force acting on the car while it is travelling **at a steady speed**?

Tick ONE box (✓)

☐ The total force is **quite a large force** forwards.



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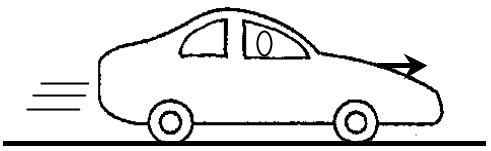
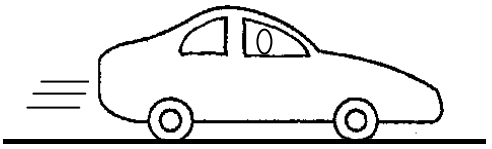


☐ The total force is **zero**.



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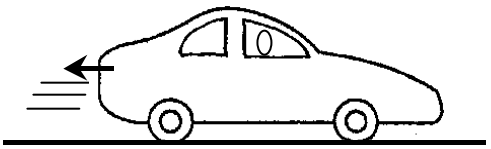
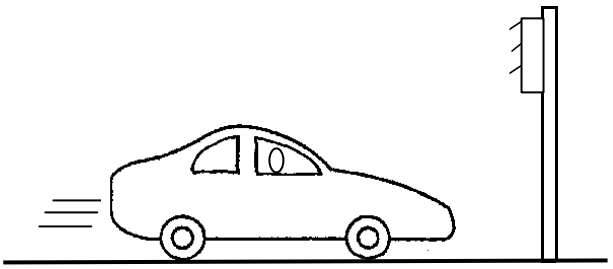


3

A car is approaching some traffic lights. The driver has put on the brakes, and the car is slowing down.



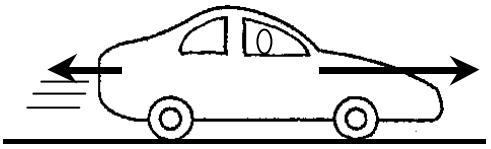
We can think of the forces acting on the car as:

- a **driving force** caused by the engine
- a **counter force** caused by air resistance and friction

(a) **The car is slowing down.** Which of the following best describes the size of these two forces?

Tick ONE box (✓)

☐ The driving force is **a lot bigger** than the counter force.



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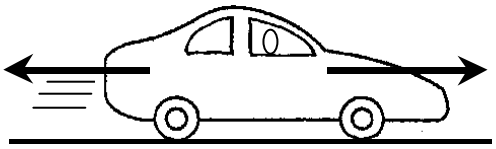

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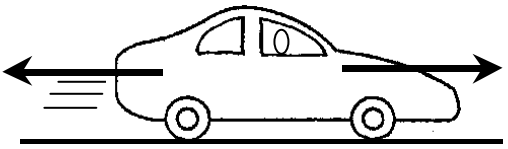

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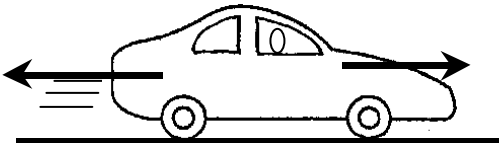
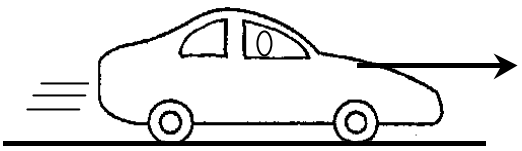


(b) The **total force** acting on the car is the sum of the driving force and the counter force. What is the total force acting on the car while it is **slowing down**?

Tick ONE box (✓)

☐ The total force is **quite a large force** forwards.



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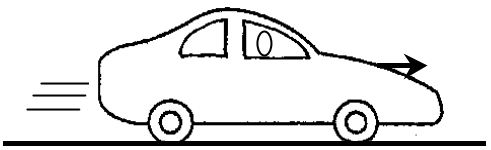

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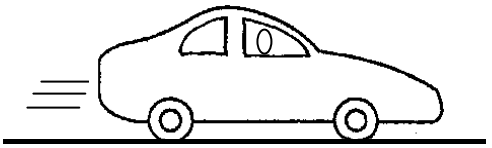

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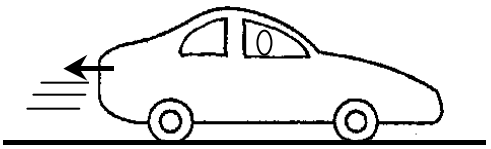
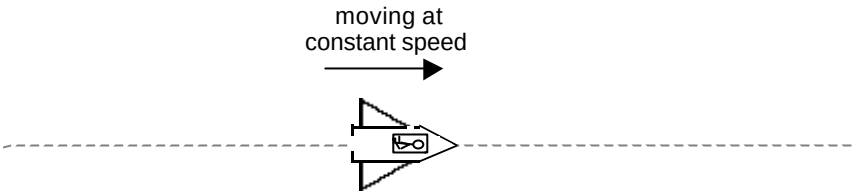


4

A spacecraft is drifting through space. It is very far away from all other objects. There is no air in space, so there is no air resistance. The spacecraft is moving in a straight line at a constant speed.



(a) What force must the rockets exert to keep the spacecraft moving in this direction at constant speed?

Tick ONE box (✓)

- ☐ No force is needed.
- ☐ A constant force towards the right.
- ☐ A steadily increasing force towards the right.

(b) The captain of the spacecraft wants to make it move in the same direction, but with its speed getting steadily greater. What force must the rockets exert to do this?

Tick ONE box (✓)

- ☐ No force is needed.
- ☐ A constant force towards the right.
- ☐ A steadily increasing force towards the right.

(c) What force is needed to make the spacecraft slow down?

Tick ONE box (✓)

- ☐ No force is needed. It will do this if you just wait.
- ☐ A constant force towards the left.
- ☐ A steadily increasing force towards the left.

5

Andy kicks a football across a level pitch. It rolls to the point B and then stops.

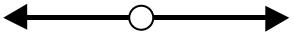
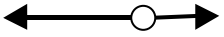
(a) How would you describe the motion of the ball at the point A?

Tick ONE box (✓)

- ☐ It is getting faster.
- ☐ It is moving at a steady speed.
- ☐ It is slowing down gradually.

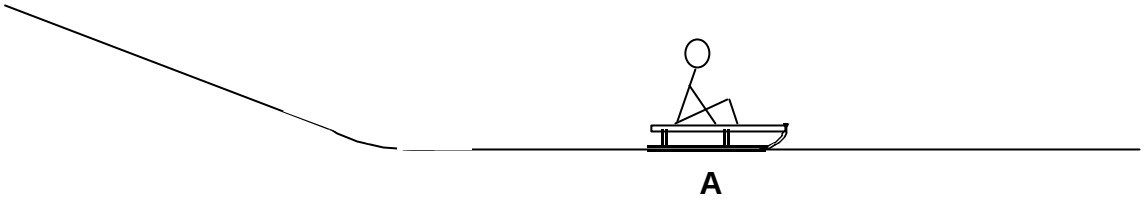
(b) Which of the following diagrams best shows the **horizontal** forces on the ball at point A? (Ignore any vertical forces.)
The length of the arrow shows the size of the force.

Tick ONE box (✓)

- ☐ 
- ☐ 
- ☐ 
- ☐ 
- ☐ 

6

A sledge slides down a slope and then on to some level ice.



(a) How would you describe the motion of the sledge at the point A?

Tick ONE box (✓)

- ☐ It is getting faster.
- ☐ It is moving at a steady speed.
- ☐ It is slowing down gradually.

(b) Which of the following diagrams best shows the **horizontal** forces on the sledge at point A? (Ignore any vertical forces.)
To simplify the diagrams, the sledge is just shown as a dot. The length of the arrow shows the size of the force.

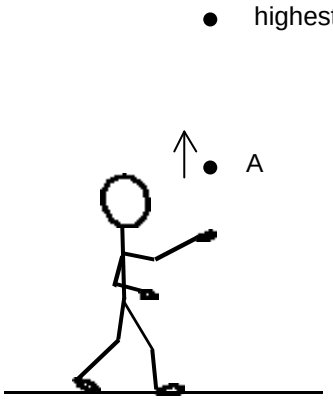
Tick ONE box (✓)

- ☐ 
- ☐ 
- ☐ 
- ☐ 
- ☐ 

7

Jan throws a tennis ball straight up into the air for a short distance and catches it when it comes down again.

Think about the ball when it is at A, on the way up to its highest point.



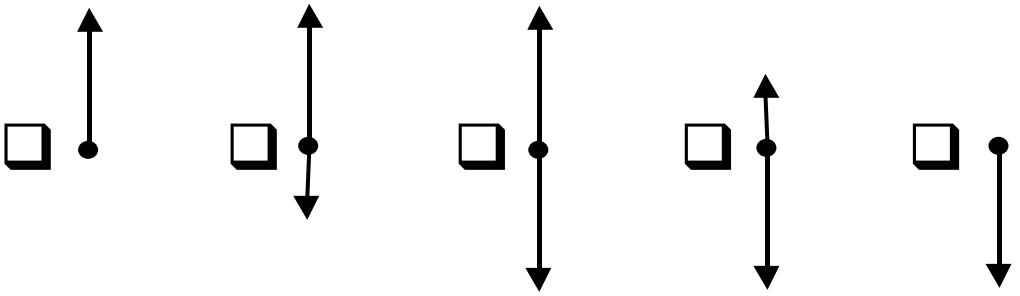
(a) How would you describe the motion of the ball at the point A?

Tick ONE box (✓)

- ❑ It is getting faster.
- ❑ It is moving at a steady speed.
- ❑ It is slowing down.

(b) Which of the following diagrams best shows the **vertical** forces on the ball at point A? (Ignore any horizontal forces.)

Tick ONE box (✓)



(c) What vertical forces are acting on the ball when it is at A, on the way up?

Tick ONE box (✓)

- ☐ The only force on the ball is the upwards force from Jan's throw.
- ☐ The only force on the ball is the force of gravity.
- ☐ There are two forces on the ball: the force of gravity and the air resistance.
- ☐ There are three forces on the ball: the force of gravity, air resistance and the force of the throw.
- ☐ None of these. The forces acting are: _____

_____

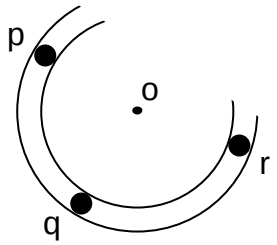
_____

_____

8

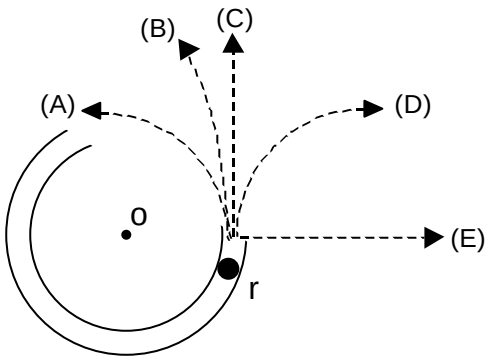
A curved tube is laid on a level table top. In the diagram below, you are looking down on this from above.

A marble is fired into the tube at point P. The force of friction is so small that it can be ignored. The marble travels round the tube at a steady speed.



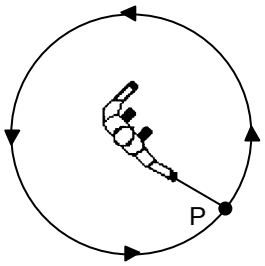
Which path in the diagram below best shows how the marble would move after it comes out of the tube and rolls across the table top?

Write one letter (A, B, C, D or E) in the box: ☐



9

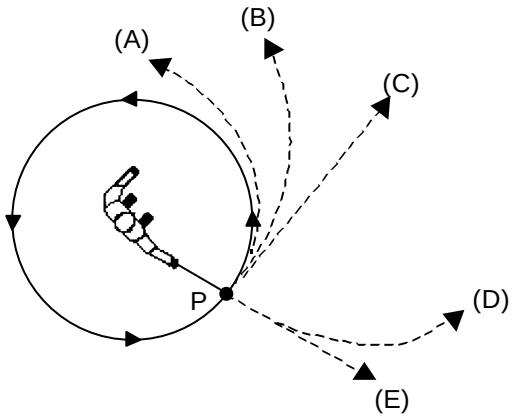
A heavy ball is tied to a rope. An athlete swings the ball round in a circle, as shown in the diagram. This is looking down on the athlete from above.



When the ball is at the point P in the diagram, the rope suddenly breaks near the ball.

Which path in the diagram below best shows how the ball would move after the rope breaks?

Write one letter (A, B, C, D or E) in the box: ☐



10

Forces on a tin of beans

A tin of beans is dropped from about 10 cm above a foam cushion.

On the diagrams below, draw all the forces acting on the tin:

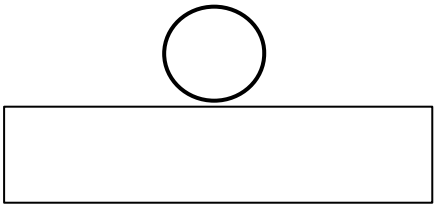
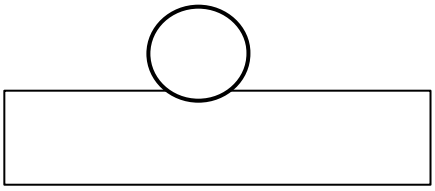
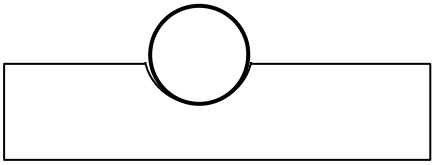
(a) just before it touches the cushion,
(b) when it has touched the cushion and is moving down into it,
(c) when it has come to rest on the cushion,
(d) when it is lying on a table.

Represent forces:

- by drawing arrows to show the direction of each force,

- with the **length** of the arrow representing the **size** of the force.

Label each force to indicate what it is.

(a) just before it touches the cushion 	(b) moving down into the cushion 
(c) has finally come to rest on the cushion 	(d) at rest on a table